Taking Probabilistic Monitoring Data to the Next Level: Evaluating Stressor Risk in Aquatic Life Use Total Maximum Daily Loads

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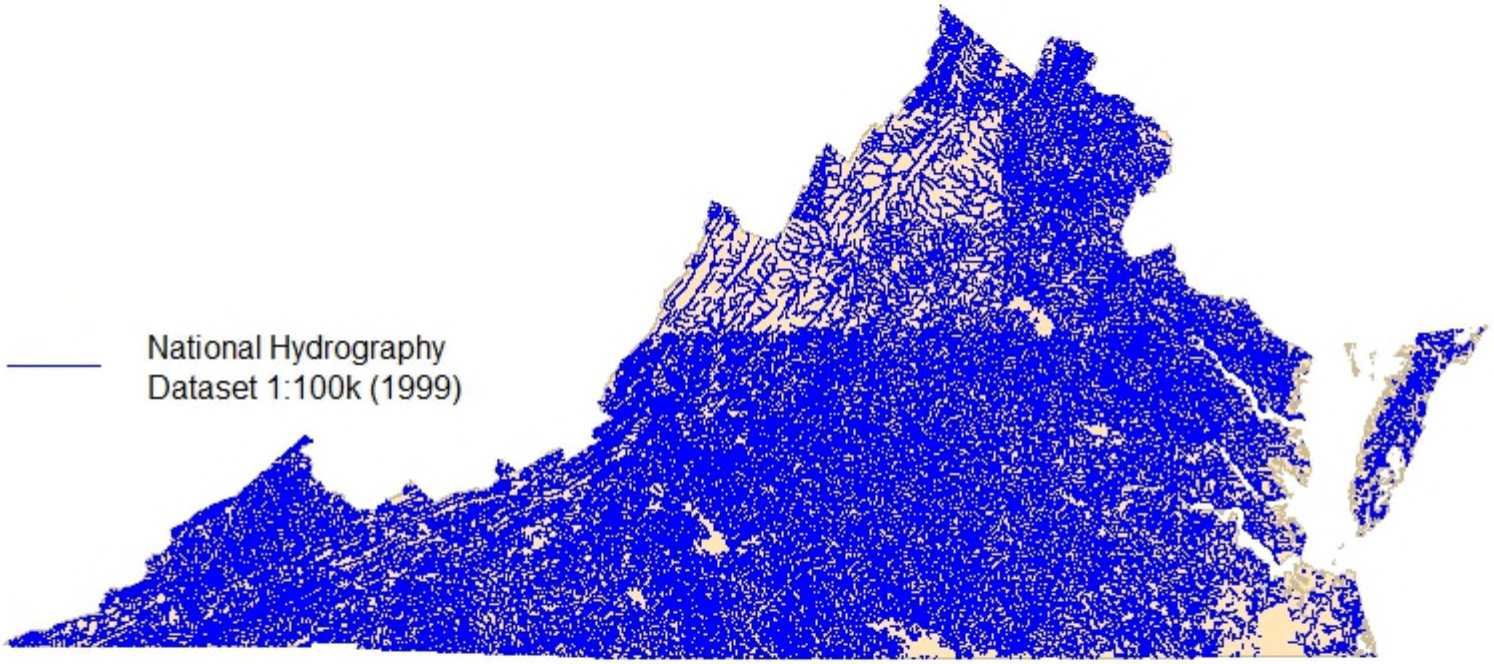
DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Freshwater Probabilistic Monitoring in Virginia



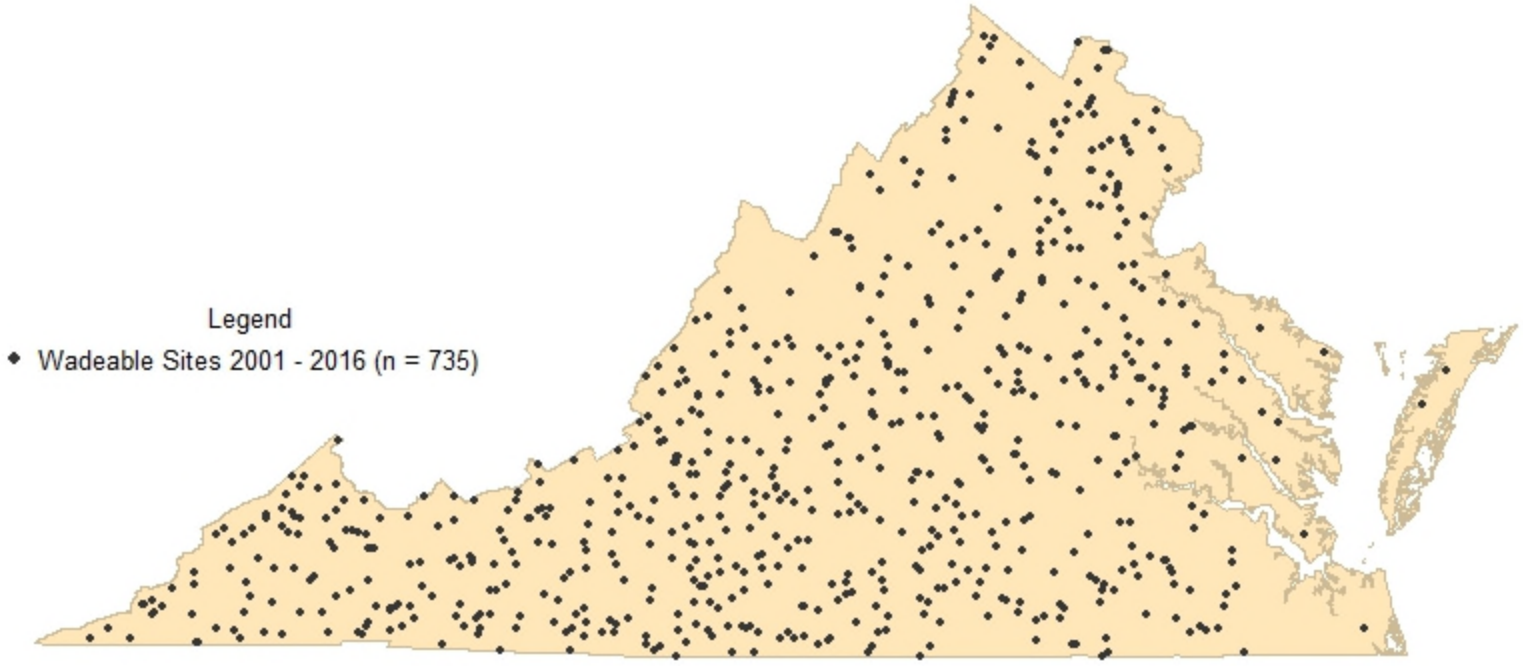
Provides estimates for all perennial, non-tidal stream and river miles which equates to approximately 49,100 miles across Virginia

~ 41,500 miles wadeable

~ 1,200 miles non-wadeable

~ 5,000 miles wetlands

Freshwater Probabilistic Monitoring in Virginia

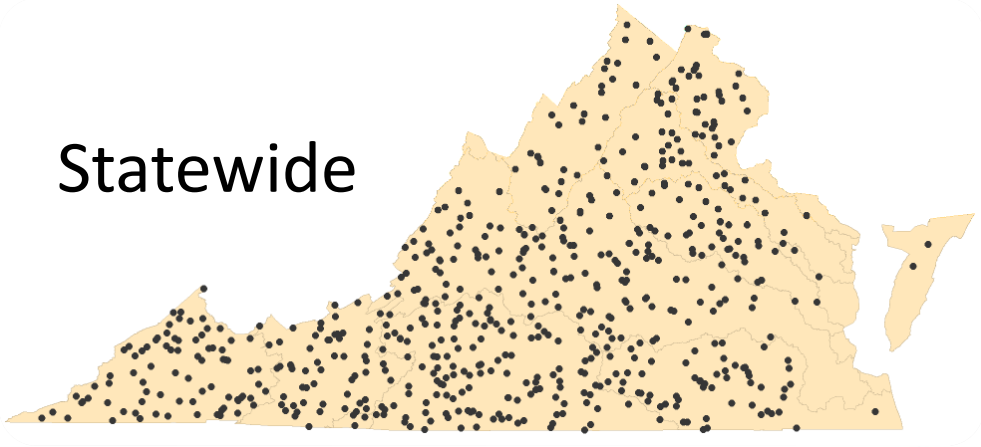


Monitoring statewide 2001 - present
~ 60 ProbMon Sites / Year

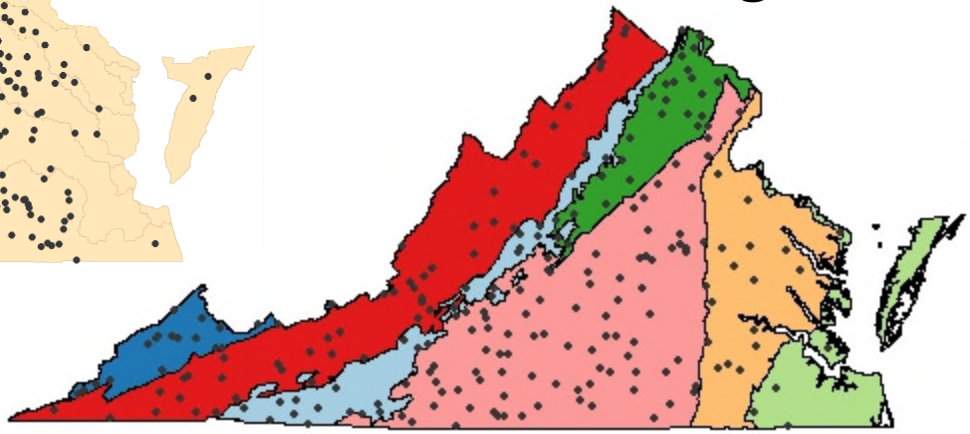
735 paired benthic and water chemistry/habitat data points (2001 – 2016)

Analysis Scale

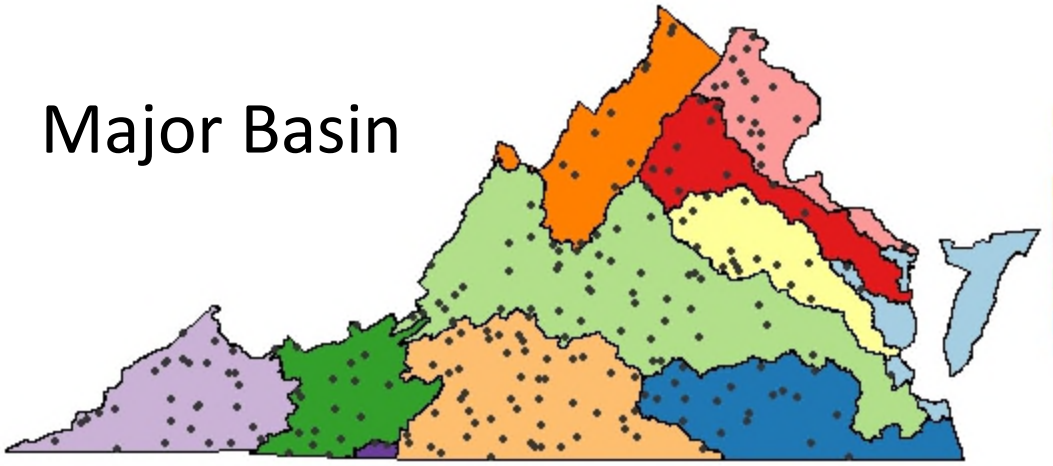
Statewide



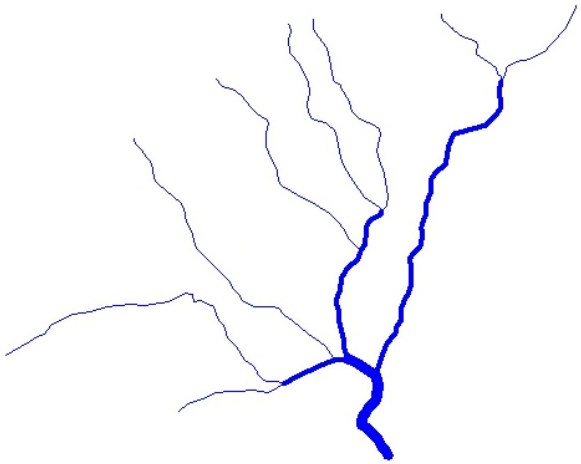
US EPA Level III Ecoregion



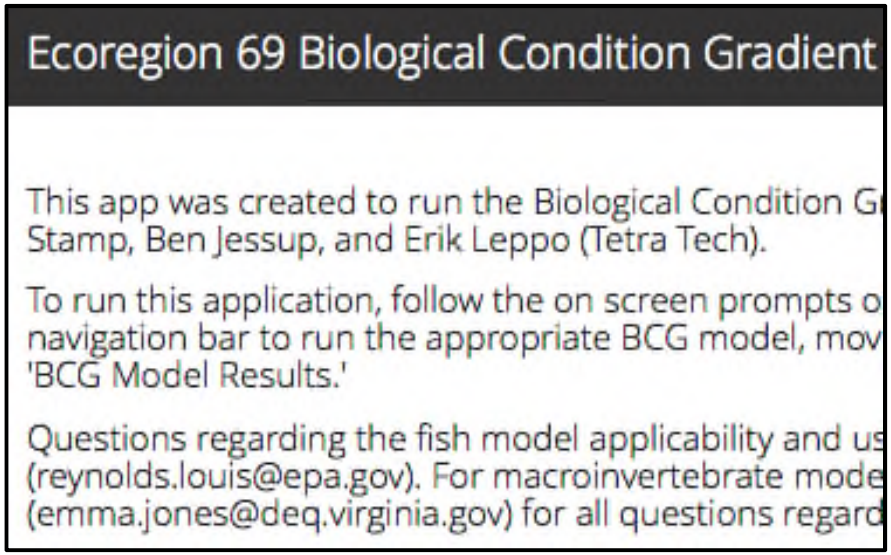
Major Basin

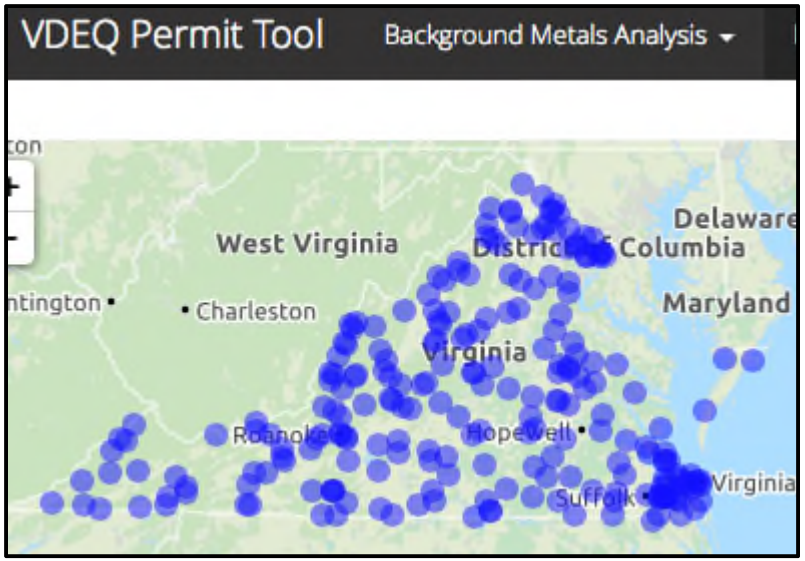


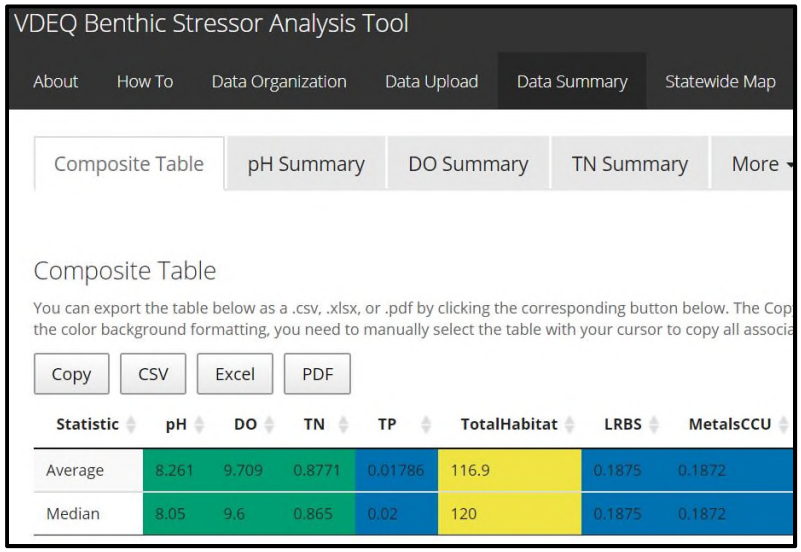
Stream Order



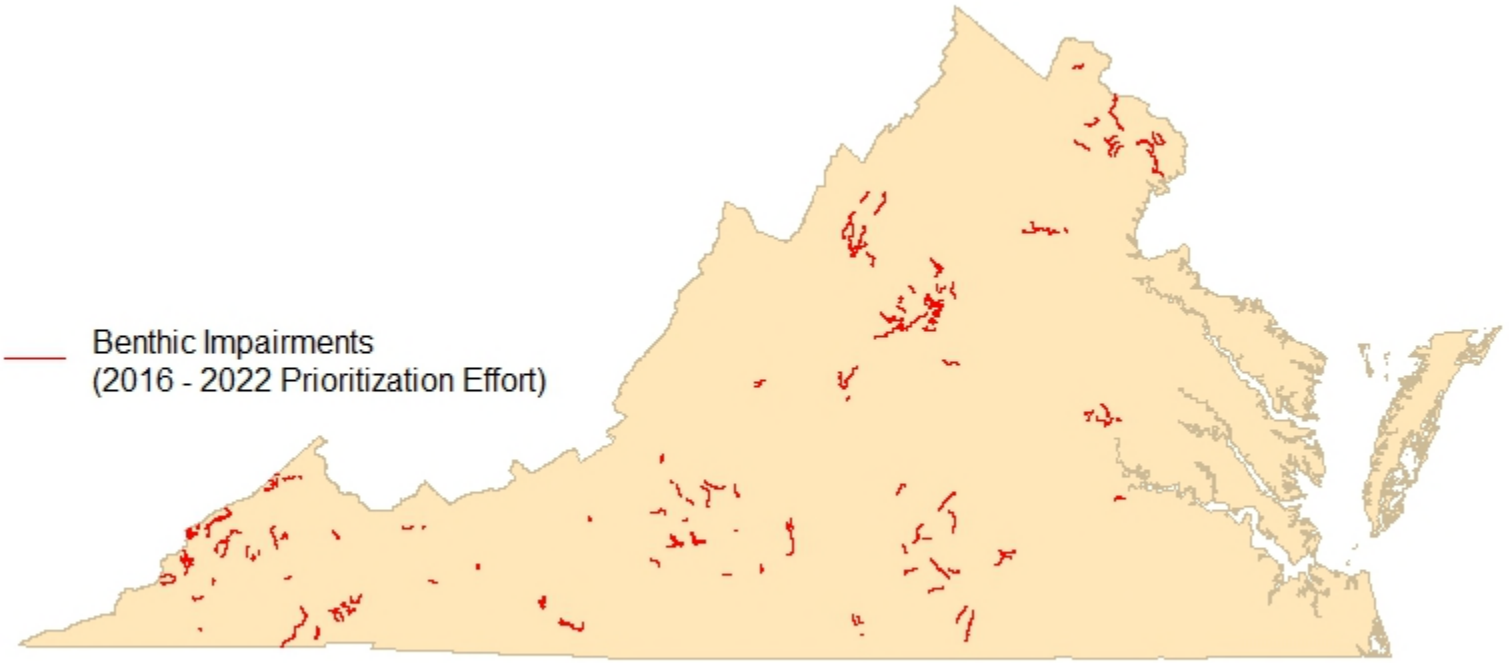
ProbMon Data Applications





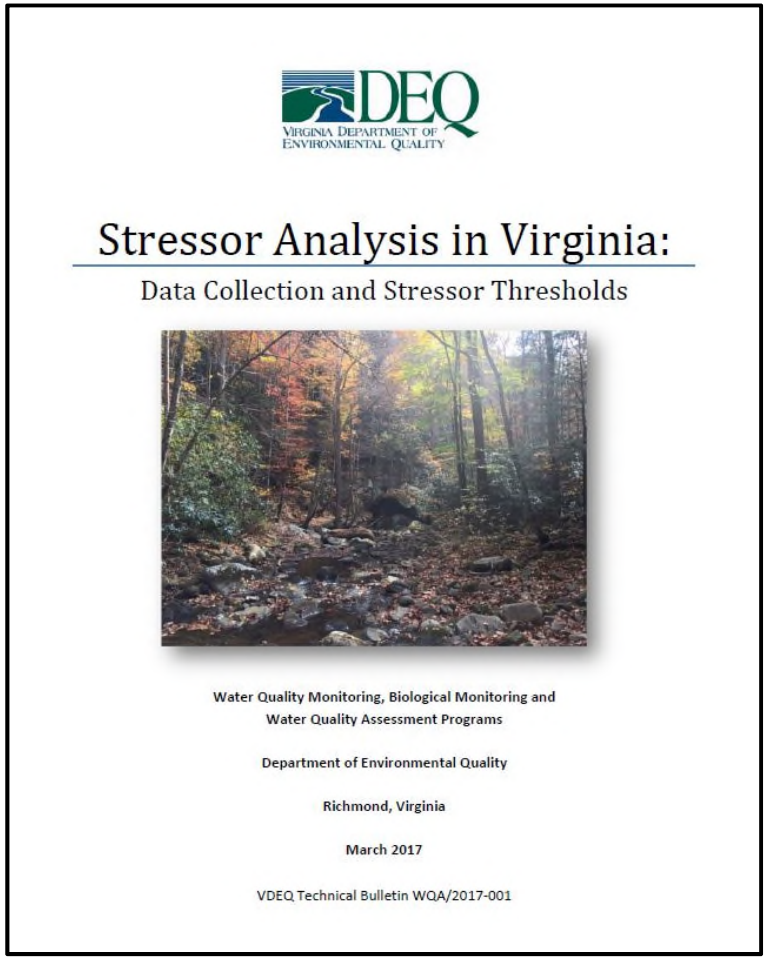


Stressor Analysis in Virginia



- Virginia's Prioritization effort includes 204 benthic macroinvertebrate community impaired segments (assessment units with benthic cause)
  - Identified as either "TMDL" or "TMDL alternative"
  - **Commitment to EPA for completion: 2016-2022**
- Stressor analyses need to be developed internally or by a contractor

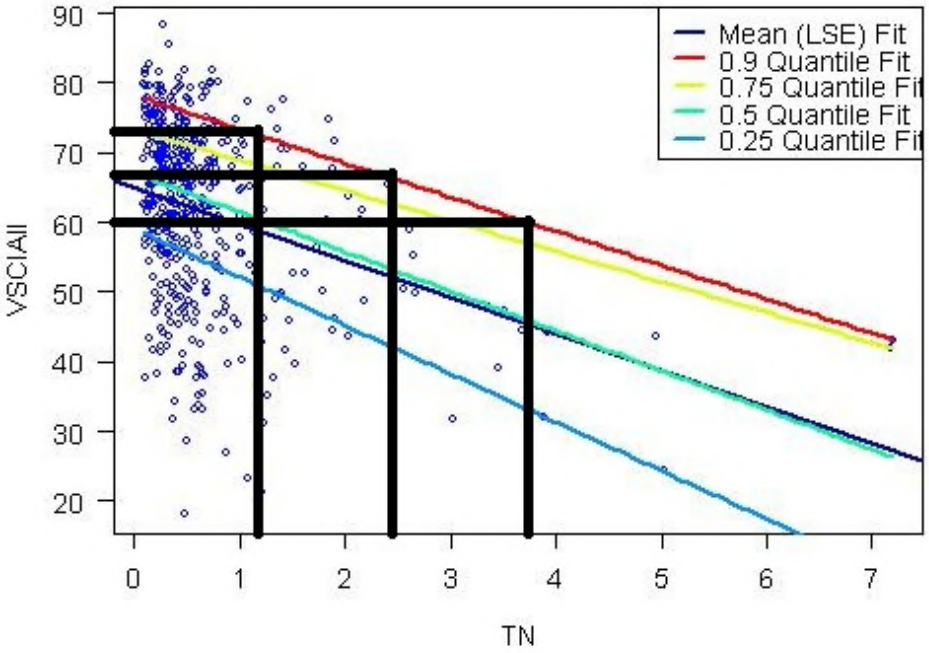
Stressor Analysis in Virginia (continued)



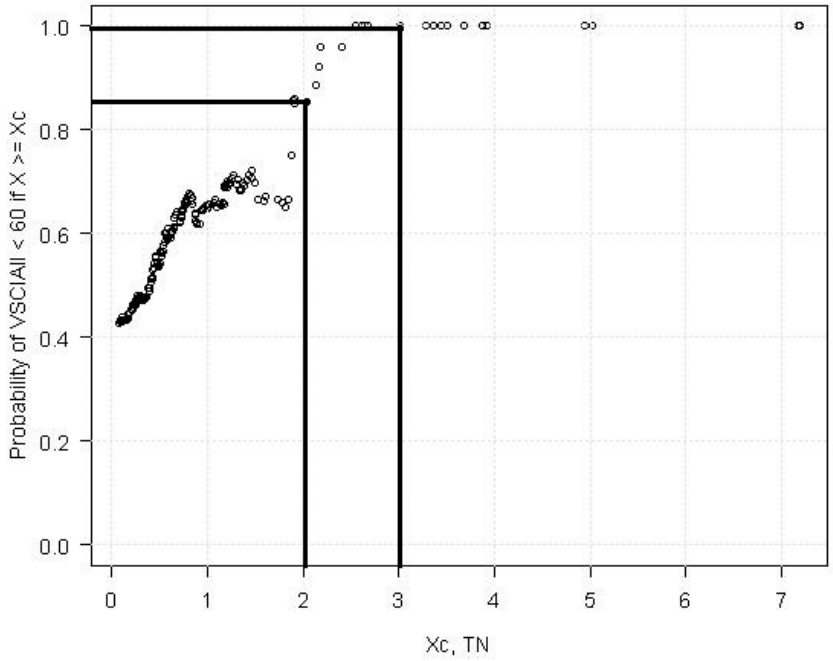
- Identifies the cause of the benthic macroinvertebrate community shift
- Weight-of-evidence approach
- Relies on all available data
- Parameters classified as…
  - Non-stressor
  - Possible stressor
  - Most probable stressor
- Multiple stressors may be identified

Developing Stressor Thresholds: Statistical Approach

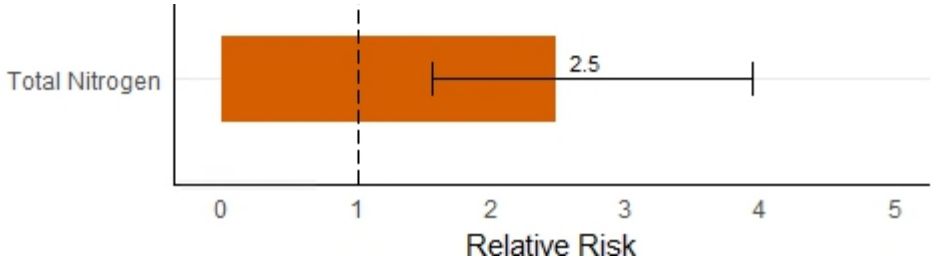
Quantile Regression



Conditional Probability



Relative Risk



Developing Stressor Thresholds

- Probabilistic Data used to define parameter thresholds:

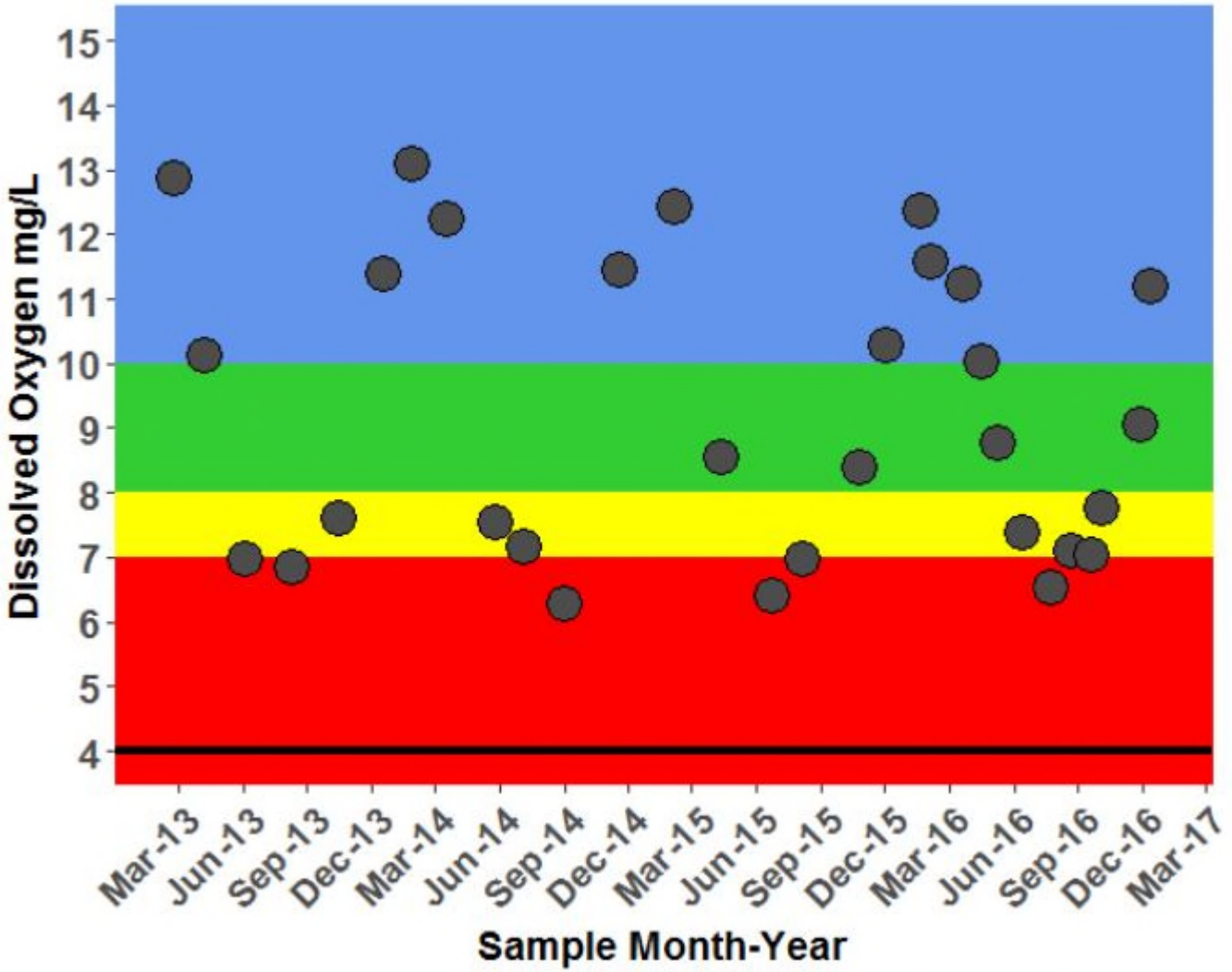
Probability of Stress to Aquatic Life
High
Medium
Low
None

Stressor Parameters

- Dissolved Oxygen
- pH
- Total Phosphorus
- Total Nitrogen
- Total Habitat
- Ionic Strength
  - Dissolved Sulfates
  - Dissolved Chloride
  - Dissolved Potassium
  - Dissolved Sodium
  - Specific Conductance / Total Dissolved Solids
- Relative Bed Stability (Quantitative Habitat analysis)
- Dissolved Metals (Cumulative Criterion Unit)

Dissolved Oxygen	
Probability of Stress to Aquatic Life	**Concentration (mg/L)**
High	< 7
Medium	> 7, < 8
Low	> 8, < 10
None	> 10

Context is Everything



Composite Table | pH Summary | DO Summary | TN Summary | More

Composite Table

You can export the table below as a .csv, .xlsx, or .pdf by clicking the corresponding button below. The Copy button copies all table data for you to put into any spreadsheet program. If you want the color background formatting, you need to manually select the table with your cursor to copy all associated formatting to a spreadsheet program.

Copy | CSV | Excel | PDF

Statistic	pH	DO	TN	TP	TotalHabitat	LRBS	MetalsCCU	SpCond	TDS	DSulfate	DChloride	DPotassium	DSodium
Average	8.261	9.709	0.8771	0.01786	116.9	0.1875	0.1872	492.5	315	31.7	19.4	1.305	9.63
Median	8.05	9.6	0.865	0.02	120	0.1875	0.1872	520	315	31.7	19.4	1.305	9.63

Risk Category

- High Probability of Stress to Aquatic Life
- Medium Probability of Stress to Aquatic Life
- Low Probability of Stress to Aquatic Life
- No Probability of Stress to Aquatic Life

Report Output:

Click below to save a .HTML version of all the tables and graphics associated with the input station. You can save this to a .pdf after initial HTML conversion (File -> Print -> Save as PDF).

Generate CDF Report

Tool Benefits

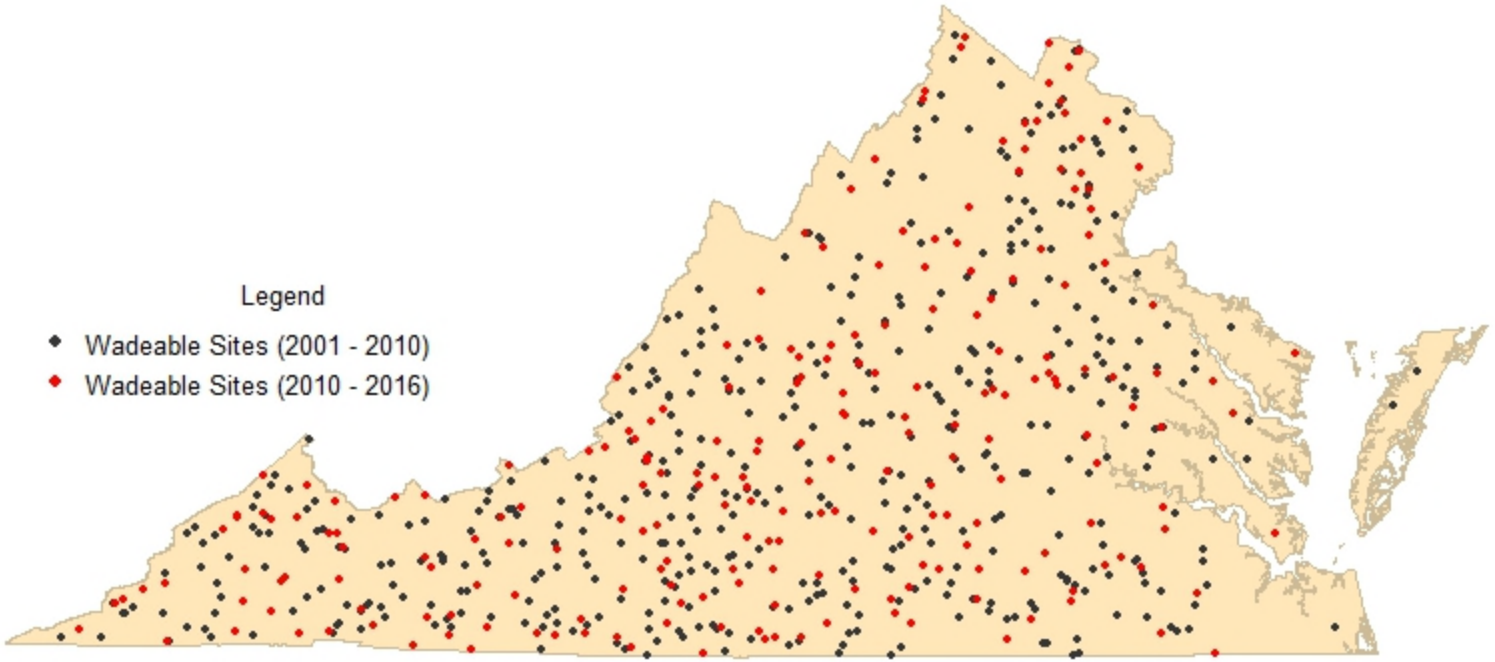
Anticipated:

- **Standardize thresholds statewide**
- Increase biological knowledge of TMDL coordinators
- **Simplify analytical updates with increasing *n***
- Standardize data collection for follow up monitoring
- Standardize data manipulation/analyses
- Expedite data manipulation/analyses
- **Standardize reporting process and products**
- Expedite reporting process
- **Cost savings**

Unanticipated:

- Inadvertently developed nesting rationale and landowner report tools
- Build culture of reproducible reports/research
- Introduce automation to regular business practices
- Initiate open source culture within VDEQ
- **Gateway app** for the development of additional analytical applications for cross media business needs

Probabilistic Monitoring Sites: 2001-2016 (*n* = 735)



Paired benthic and water chemistry/habitat data points

Published report (2001 – 2010): ***n* = 474**

Interactive Application (2001 – 2016): ***n* = 735**

Tool Benefits

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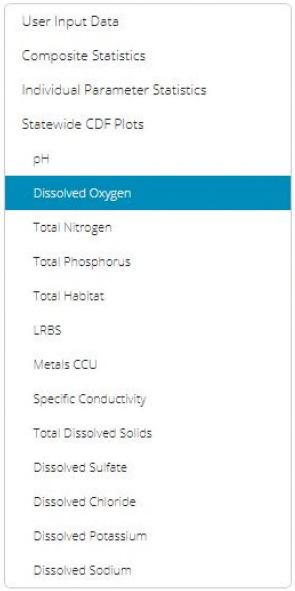
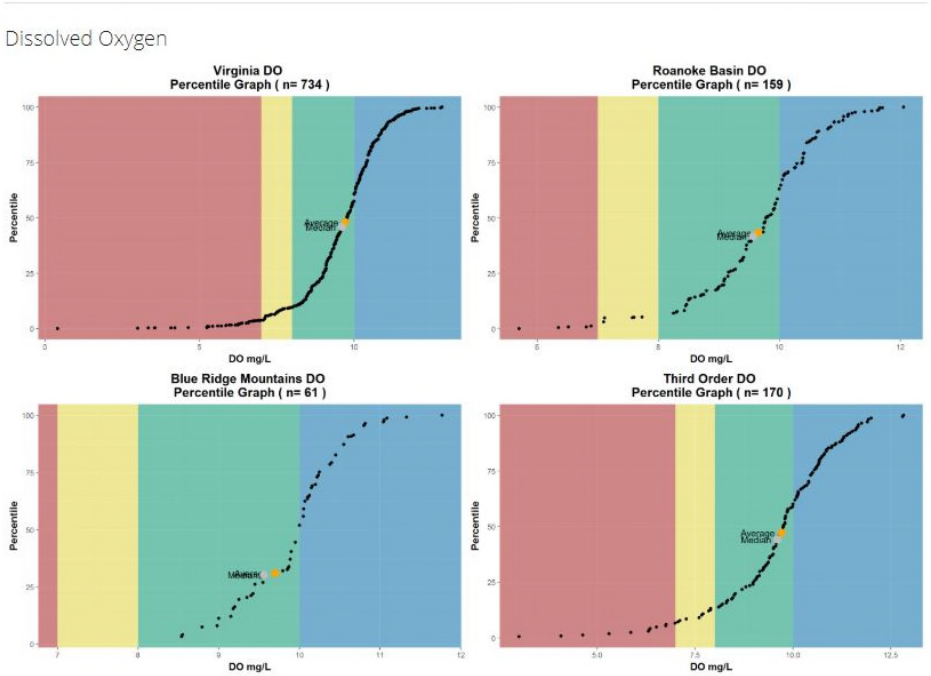
Tool Uses (so far)

Benthic Stressor Reports for:

- Catawba Creek (preliminary EPA approval)
- Unnamed Tributary to Roanoke River
- Mountain Run
- Crane Creek
- Briery Creek
- Smith River
- Naked Creek
- Lynch Creek
- Reed Creek
- Allens Branch
- Devil Fork
- Bark Camp Branch

- Monitoring/Landowner Reports
- Assessment/Monitoring planning
- Dissolved metals assessment
- BCG/Tolerance document





Stressor Tool Demo

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-06-074

User Data | Metals CCU Analysis, Single Site

User Uploaded Data

Please fill in the Basin, Ecoregion, and Stream Order fields appropriately.

Basin: Roanoke Basin

Ecoregion: Blue Ridge Mountains

Stream Order: Third Order

StationID	CollectionDateTime	Longitude	Latitude	pH	DO	TN	TP	TotalHabitat	Ll
4ADEE000.06	2012-05-21	-79.9512	37.3316					120	
4ADEE000.06	2012-09-25	-79.9512	37.3316					128	
4ADEE000.06	2015-02-04	-79.9512	37.3316	7.91	12.95	0.76	0.01		
4ADEE000.06	2015-04-06	-79.9512	37.3316	11.91	8.19	0.93	0.01		
4ADEE000.06	2015-05-12	-79.9512	37.3316	8.09	9.07			113	
4ADEE000.06	2015-06-16	-79.9512	37.3316	8.14	8.17	0.89	0.03		
4ADEE000.06	2015-08-04	-79.9512	37.3316	7.97	7.55	0.98	0.02		
4ADEE000.06	2015-10-07	-79.9512	37.3316	8	9.63	1.14	0.02		
4ADEE000.06	2015-11-16	-79.9512	37.3316	8.06	11.03			99	

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Generate CDF Report

Total Habitat Summary

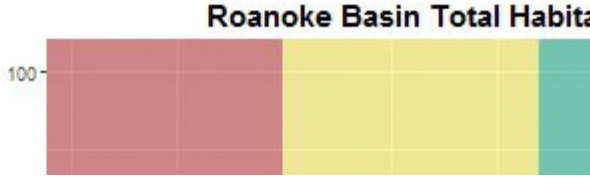
StationID	Average (unitless)	Median (unitless)
4ADEE000.06	116.9	120

Subpopulation	Average Percentile	Median Percentil
Virginia	14.0467847036248	16.3452068910917
Roanoke Basin	15.2631837509921	18.9808113183198
Blue Ridge Mountains	4.5013109276962	4.5013109276962
Third Order	11.8181818181818	14.2424242424242

Risk Category	Total Habitat (unitless)
High Probability of Stress to Aquatic Life	< 100
Medium Probability of Stress to Aquatic Life	> 100, < 130
Low Probability of Stress to Aquatic Life	> 130, < 150
No Probability of Stress to Aquatic Life	> 150

Select Dataset to Plot

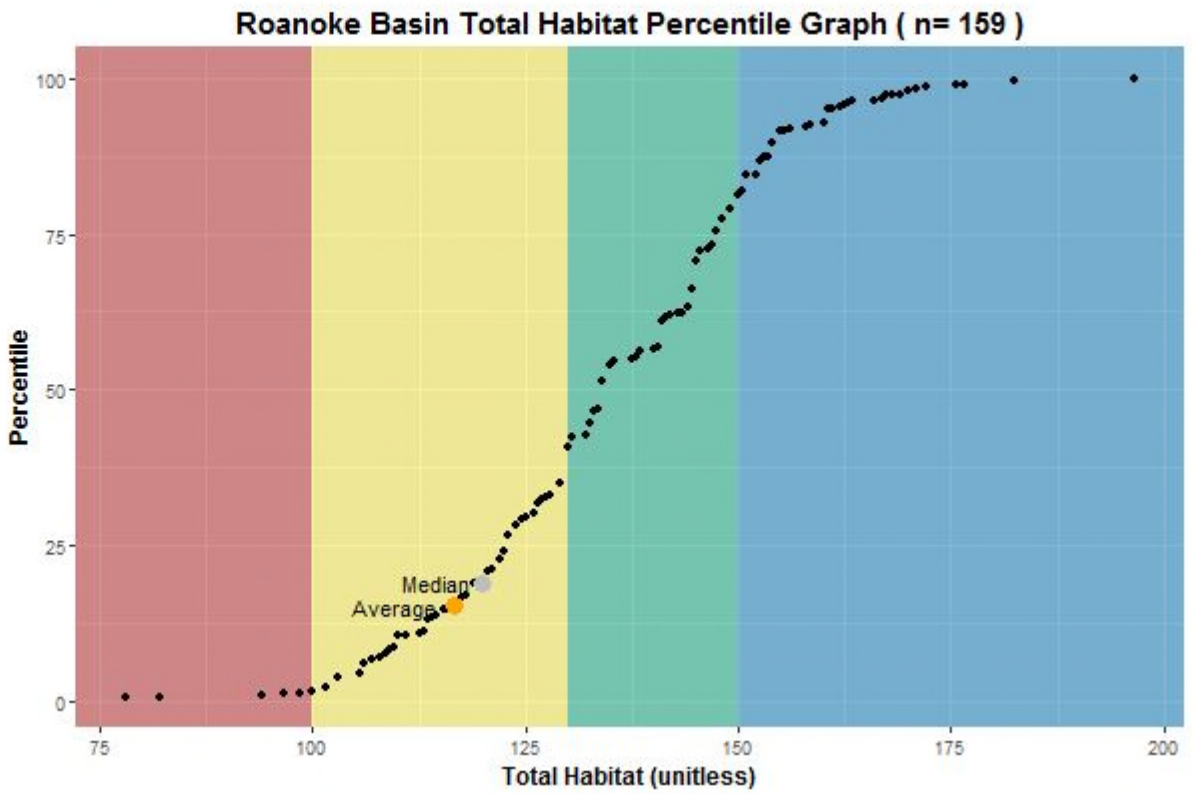
Roanoke Basin



Total Habitat (unitless)
< 100
> 100, < 130
> 130, < 150
> 150

Select Dataset to Plot

Roanoke Basin



enthic Stressor Analysis Tool | About | How To | Data Organization | Data Upload | Data Summary | Statewide Map | Dissolved Me

ructions:

se upload dissolved metals data
flat file (.csv). This section of the
llows for multiple sites to be
ded. All data uploaded to the
nust be formatted correctly. If
re unsure whether your data is
correct format, please
load the 'template_metals.csv'
st to check your data structure.

Download metals template

Dissolved Metals (flat file)

wse... | LOGImanipulatedMe

Upload complete

User Data | Dissolved Metals Data Summary

Dissolved Metals Statewide

Select Site to Review

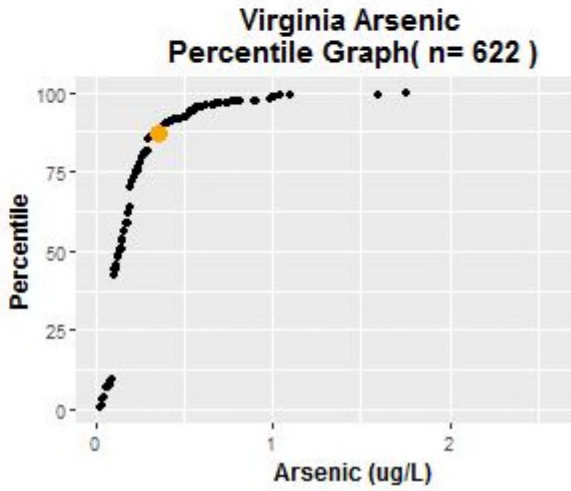
4ADEE000.06

After uploading data from one or more sites on the previous tab ('User Data'), you will be able to scroll through sites to analyze dissolved metals against statewide percentiles.

Select Dissolved Metal to Plot

Arsenic

Add Acute Criteria to CDF Plot.



Dissolved Metal	Measure	Statewide Percentile	Acute Criteria	Chronic Criteria	PWS Criteria	Chronic Assessment	Acute Assessment	PWS Assessment
Calcium (mg/L)	64.6	97.3						
Magnesium (mg/L)	15.3	93.9						
Arsenic (ug/L)	0.35	87.1	340	150	10	No Exceedance	No Exceedance	No Exceedance
Barium (ug/L)	56.7	97			2000			No Exceedance
Beryllium (ug/L)	0.2	98.7						
Cadmium (ug/L)	0.1	98	9.74	2.14	5	No Exceedance	No Exceedance	No Exceedance
Chromium (ug/L)	0.65	80.5	1103	143	100	No Exceedance	No Exceedance	No Exceedance
Copper (ug/L)	0.64	78.5	28.7	17.8	1300	No Exceedance	No Exceedance	No Exceedance
Iron (ug/L)	20	12.2			300			No Exceedance
Lead (ug/L)	0.1	86.4	332	37.7	15	No Exceedance	No Exceedance	No Exceedance
Manganese (ug/L)	6.95	28.3			50			No Exceedance
Thallium (ug/L)	0.02	40.7			0.24			No Exceedance

Upload Macroinvertebrate Data (.xlsx)

Browse... 4ADEE000.06_Family Metrics VSCI Calculation.xlsx

Upload complete

Upload Habitat Data (.xlsx)

Browse... 4ADEE000.06_Habitat parameters Query LB.xlsx

Upload complete

Stream Name

Deer Branch

Click the appropriate generate report button to generate a preliminary report based on the data analyzed by the Benthic Stressor Tool and additional user input datasets. The included text is preliminary language that is applicable to most reports. Please revise according to your needs.

Generate Report- VSCI

Generate Report- VCPMI Ecoregion 63 + Chowan Basin

Generate Report- VSCI Ecoregion 65 - Chowan Basin

Contact Information

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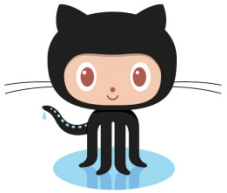
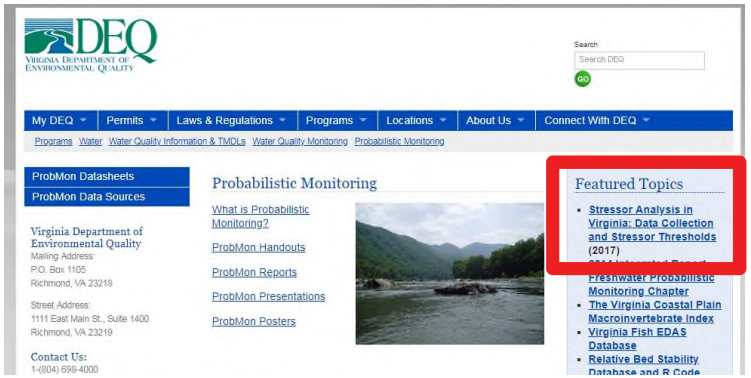
Jason Hill jason.hill@deq.virginia.gov



www.github.com/VDEQ/VDEQ_BenthicStressorAnalysis



www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/ProbabilisticMonitoring.aspx